INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/41616

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N27/407

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A X	US 5 817 920 A (ACHEY DAVID EARL ET AL) 6 October 1998 (1998-10-06) abstract column 2, line 10 - line 80 column 3, line 42 - line 65; figure 1	1-12, 14-20 13
A	US 5 886 248 A (FOURNIER ROBERT GREGORY ET AL) 23 March 1999 (1999-03-23) abstract column 5, line 27 - line 46; figure 4	1-20
A	EP 0 811 840 A (NGK SPARK PLUG CO) 10 December 1997 (1997-12-10) abstract page 6, line 36 -page 7, line 18; figure 1	1-20

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 June 2001	03/07/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kempf, G

1

Form PCT/ISA/210 (second sheet) (July 1992)

TRANSMITTAL LETTER TO THE UNITED STATES RECEIVING OFFICE

Date	26 October 2000 (26.10.00)
International Applic. No.	
Attorney Docket No.	DP-301244 PCT

I. Certification under 37 CFR 1.10 (if applicable)

EL 540189100US	26 October 2000
Express Mail mailing number	Date of Deposit

I hereby certify that the application/correspondence attached hereto is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to Assistant Commissioner for Patents, Washington, D.C. 20231.

Barbara Latourelle	Barbara Latourelle
Signature of person mailing correspondence	Typed or printed name of person mailing correspondence

II. ☒ New International Application

TITLE	A GAS SENSOR TERMINAL ASSEMBLY AND METHOD OF PRODUCING SAME	Earliest priority date (Day/Month/Year): 27 October 1999 (27.10.99)

SCREENING DISCLOSURE INFORMATION: In order to assist in screening the accompanying international application for purposes of determining whether a license for foreign transmittal should and could be granted and for other purposes, the following information is supplied. (Note: check as many boxes as apply):

A. ☐ The invention disclosed was **not** made in the United States.

B. ☐ There is no prior U.S. application relating to this invention.

C. ☒ The following prior U.S. application(s) contain subject matter which is related to the invention disclosed in the attached international application. *(NOTE: priority to these applications may or may not be claimed on form PCT/RO/101 (Request) and this listing does not constitute a claim for priority).*

application no.	60/161,839	filed on	27 October 1999 (27.10.99)
application no.		filed on	

D. ☐ The present international application ☐ is identical ☐ contains less subject matter than that found in the prior U.S. application(s) identified in paragraph C.

E. ☒ The present international application ☒ contains additional subject matter not found in the prior U.S. application(s) identified in paragraph C. above. The additional subject matter is found on pages throughout the application and ☒ **DOES NOT ALTER** ☐ **MIGHT BE CONSIDERED TO ALTER** the general nature of the invention in a manner which would require the U.S. application to have been made available for inspection by the appropriate defense agencies under 35 U.S.C. 181 and 37 CFR 5.1. See 37 CFR 5.15

III. ☐ A Response to an Invitation from the RO/US. The following document(s) is (are) enclosed:

A. ☐ A Request for An Extension of Time to File a Response

B. ☐ A Power of Attorney (General or Regular)

C. ☐ Replacement pages:

pages		of the request (PCT/RO/101)	pages		of the figures
pages		of the description	pages		of the abstract
pages		of the claims			

D. ☐ Submission of Priority Documents

Priority document		Priority document	

E. ☐ Fees as specified on attached Fee Calculation sheet form PCT/RO/101 annex

IV. ☐ A Request for Rectification under PCT 91 ☐ **A Petition** ☐ **A Sequence Listing Diskette**

V. ☐ Other (please specify):

The person signing this form is the:		
☐	Applicant	
☒	Attorney/Agent (Reg. No.) Reg. No. 34,676	Pamela J. Curbelo Typed name of signer
☐	Common Representative	Signature

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

receiving Office use only

International Application No.

International Filing Date

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference *(if desired) (12 characters maximum)* DP-301244 PCT

Box No. I TITLE OF INVENTION

A GAS SENSOR TERMINAL ASSEMBLY AND METHOD OF PRODUCING SAME

Box No. II APPLICANT

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

DELPHI TECHNOLOGIES, INC.
Legal Staff MC 480-414-420
1450 West Long Lake Road
Troy, MI 48007-5052
US

☐ This person is also inventor.

Telephone No.
(248) 267-5513

Facsimile No.
(248) 267-5559

Teleprinter No.

State *(that is, country)* of nationality:
US

State *(that is, country)* of residence:
US

This person is applicant for the purposes of: ☒ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

DUCE, Richard W.
1111 McKinley Road
Flushing, MI 48430
US

This person is:

☐ applicant only

☒ applicant and inventor

☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

☒ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as: ☒ agent ☐ common representative

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)*

CURBELO, Pamela J.
CANTOR COLBURN LLP
55 Griffin Road South
Bloomfield, CT 06002
US

Telephone No.
(860) 286-2929

Facsimile No.
(860) 286-0115

Teleprinter No.

☐ **Address for correspondence:** Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Continuation of Box No. III FURTHER APPLICANTS AND/OR (FURTHER) INVENTOR(S)

If none of the following sub-boxes is used, this sheet is not to be included in the request.

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

McCAULEY, Kathryn M.
610 East Genesee Street
Durand, MI 48429
US

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

KUISELL, Richard C.
1384 Sawdust Corners Road
Lapeer, MI 48446
US

This person is:
- ☐ applicant only
- ☒ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☒ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

Name and address: *(Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)*

This person is:
- ☐ applicant only
- ☐ applicant and inventor
- ☐ inventor only *(If this check-box is marked, do not fill in below.)*

State *(that is, country)* of nationality:

State *(that is, country)* of residence:

This person is applicant for the purposes of: ☐ all designated States ☐ all designated States except the United States of America ☐ the United States of America only ☐ the States indicated in the Supplemental Box

☐ Further applicants and/or (further) inventors are indicated on another continuation sheet.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) *(mark the applicable check-boxes; at least one must be marked):*

Regional Patent

☐ **AP ARIPO Patent:** **GH** Ghana, **GM** Gambia, **KE** Kenya, **LS** Lesotho, **MW** Malawi, **MZ** Mozambique, **SD** Sudan, **SL** Sierra Leone, **SZ** Swaziland, **TZ** United Republic of Tanzania, **UG** Uganda, **ZW** Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT

☐ **EA Eurasian Patent:** **AM** Armenia, **AZ** Azerbaijan, **BY** Belarus, **KG** Kyrgyzstan, **KZ** Kazakhstan, **MD** Republic of Moldova, **RU** Russian Federation, **TJ** Tajikistan, **TM** Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT

☒ **EP European Patent:** **AT** Austria, **BE** Belgium, **CH and LI** Switzerland and Liechtenstein, **CY** Cyprus, **DE** Germany, **DK** Denmark, **ES** Spain, **FI** Finland, **FR** France, **GB** United Kingdom, **GR** Greece, **IE** Ireland, **IT** Italy, **LU** Luxembourg, **MC** Monaco, **NL** Netherlands, **PT** Portugal, **SE** Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT

☐ **OA OAPI Patent:** **BF** Burkina Faso, **BJ** Benin, **CF** Central African Republic, **CG** Congo, **CI** Côte d'Ivoire, **CM** Cameroon, **GA** Gabon, **GN** Guinea, **GW** Guinea-Bissau, **ML** Mali, **MR** Mauritania, **NE** Niger, **SN** Senegal, **TD** Chad, **TG** Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT *(if other kind of protection or treatment desired, specify on dotted line)* .....

National Patent *(if other kind of protection or treatment desired, specify on dotted line):*

☐ **AE** United Arab Emirates
☐ **AG** Antigua and Barbuda
☐ **AL** Albania .....
☐ **AM** Armenia .....
☐ **AT** Austria .....
☐ **AU** Australia .....
☐ **AZ** Azerbaijan
☐ **BA** Bosnia and Herzegovina .....
☐ **BB** Barbados
☐ **BG** Bulgaria .....
☐ **BR** Brazil .....
☐ **BY** Belarus .....
☐ **BZ** Belize
☐ **CA** Canada
☐ **CH and LI** Switzerland and Liechtenstein
☐ **CN** China .....
☐ **CR** Costa Rica .....
☐ **CU** Cuba .....
☐ **CZ** Czech Republic .....
☐ **DE** Germany .....
☐ **DK** Denmark .....
☐ **DM** Dominica
☐ **DZ** Algeria .....
☐ **EE** Estonia .....
☐ **ES** Spain .....
☐ **FI** Finland .....
☐ **GB** United Kingdom
☐ **GD** Grenada
☐ **GE** Georgia .....
☐ **GH** Ghana .....
☐ **GM** Gambia
☐ **HR** Croatia .....
☐ **HU** Hungary .....
☐ **ID** Indonesia
☐ **IL** Israel .....
☐ **IN** India .....
☐ **IS** Iceland
☒ **JP** Japan .....
☐ **KE** Kenya .....
☐ **KG** Kyrgyzstan .....
☐ **KP** Democratic People's Republic of Korea .....
☒ **KR** Republic of Korea .....
☐ **KZ** Kazakhstan .....
☐ **LC** Saint Lucia
☐ **LK** Sri Lanka
☐ **LR** Liberia
☐ **LS** Lesotho .....
☐ **LT** Lithuania
☐ **LU** Luxembourg
☐ **LV** Latvia
☐ **MA** Morocco .....
☐ **MD** Republic of Moldova .....
☐ **MG** Madagascar .....
☐ **MK** The former Yugoslav Republic of Macedonia .....
☐ **MN** Mongolia
☐ **MW** Malawi .....
☐ **MX** Mexico .....
☐ **MZ** Mozambique
☐ **NO** Norway
☐ **NZ** New Zealand .....
☐ **PL** Poland .....
☐ **PT** Portugal .....
☐ **RO** Romania
☐ **RU** Russian Federation .....
☐ **SD** Sudan
☐ **SE** Sweden
☐ **SG** Singapore
☐ **SI** Slovenia .....
☐ **SK** Slovakia .....
☐ **SL** Sierra Leone .....
☐ **TJ** Tajikistan .....
☐ **TM** Turkmenistan .....
☐ **TR** Turkey .....
☐ **TT** Trinidad and Tobago .....
☐ **TZ** United Republic of Tanzania
☐ **UA** Ukraine .....
☐ **UG** Uganda .....
☒ **US** United States of America .....
☐ **UZ** Uzbekistan .....
☐ **VN** Viet Nam .....
☐ **YU** Yugoslavia .....
☐ **ZA** South Africa .....
☐ **ZW** Zimbabwe .....

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

☐ .....

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. *(Confirmation (including fees) must reach the receiving Office within the 15-month time limit.)*

Box No. VI PRIORITY CLAIM ☐ Further priority claims are indicated in the Supplemental Box.

Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is: national application: country	regional application:* regional Office	international application: receiving Office
item (1) 27 October 1999 (27.10.99)	60/161,839	US		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) *(only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office)* identified above as item(s): (1)

** Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.*

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) *(if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):*

ISA/ EP

Request to use results of earlier search; reference to that search *(if an earlier search has been carried out by or requested from the International Searching Authority):*

Date *(day/month/year)* Number Country *(or regional Office)*

Box No. VIII CHECK LIST: LANGUAGE OF FILING

This international application contains the following **number of sheets:**

request	:	4
description (excluding sequence listing part)	:	11
claims	:	5
abstract	:	1
drawings	:	3
sequence listing part of description	:	
Total number of sheets	:	24

This international application is **accompanied** by the item(s) marked below:

1. ☒ fee calculation sheet
2. ☐ separate signed power of attorney
3. ☒ copy of general power of attorney; reference number, if any:
4. ☐ statement explaining lack of signature
5. ☐ priority document(s) identified in Box No. VI as item(s):
6. ☐ translation of international application into (language):
7. ☐ separate indications concerning deposited microorganism or other biological material
8. ☐ nucleotide and/or amino acid sequence listing in computer readable form
9. ☒ other *(specify):* Transmittal Letter

Figure of the drawings which should accompany the abstract: 2

Language of filing of the international application: English

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

Pamela J. Curbelo
Applicant's Attorney

For receiving Office use only

1. Date of actual receipt of the purported international application:
2. Drawings: ☐ received: ☐ not received:
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:
4. Date of timely receipt of the required corrections under PCT Article 11(2):
5. International Searching Authority (if two or more are competent): ISA/
6. ☐ Transmittal of search copy delayed until search fee is paid.

For International Bureau use only

Date of receipt of the record copy by the International Bureau:

This sheet is not part of and does not count as a sheet of the international application.

PCT

FEE CALCULATION SHEET

Annex to the Request

For receiving Office use only

International application No.

Date stamp of the receiving Office

Applicant's or agent's file reference: **DP-301244 PCT**

Applicant: **DELPHI TECHNOLOGIES, INC.**

CALCULATION OF PRESCRIBED FEES

1. TRANSMITTAL FEE . . . . . **240.00** T

2. SEARCH FEE . . . . . **925.00** S

International search to be carried out by **ISA/EP**

(If two or more International Searching Authorities are competent in relation to the international application, indicate the name of the Authority which is chosen to carry out the international search.)

3. INTERNATIONAL FEE

Basic Fee

The international application contains **24** sheets.

first 30 sheets **427.00** b1

0 remaining sheets x _____ additional amount = **0.00** b2

Add amounts entered at b1 and b2 and enter total at B . . **427.00** B

Designation Fees

The international application contains **4** designations.

4 number of designation fees payable *(maximum 8)* x **92.00** amount of designation fee = **368.00** D

Add amounts entered at B and D and enter total at I . . . . . **795.00** I

(Applicants from certain States are entitled to a reduction of 75% of the international fee. Where the applicant is (or all applicants are) so entitled, the

4. FEE FOR PRIORITY DOCUMENT *(if applicable)* . . . . . **15.00** P

5. TOTAL FEES PAYABLE . . . . . **1,975.00** TOTAL

Add amounts entered at T, S, I and P, and enter total in the TOTAL box

☐ The designation fees are not paid at this time.

MODE OF PAYMENT

☒ authorization to charge deposit account (see below)	☐ bank draft	☐ coupons
☒ cheque	☐ cash	☐ other *(specify)*:
☐ postal money order	☐ revenue stamps	

DEPOSIT ACCOUNT AUTHORIZATION *(this mode of payment may not be available at all receiving Offices)*

The RO/ **US**

☐ is hereby authorized to charge the total fees indicated above to my deposit account.

☒ *(this check-box may be marked only if the conditions for deposit accounts of the receiving Office so permit)* is hereby authorized to charge any deficiency or credit any overpayment in the total fees indicated above to my deposit account.

☐ is hereby authorized to charge the fee for preparation and transmittal of the priority document to the International Bureau of WIPO to my deposit account.

06-1130	**26 October 2000 (26.10.00)**	
Deposit Account No.	Date *(day/month/year)*	Signature

PCT

GENERAL POWER OF ATTORNEY

(for several international applications filed under the Patent Cooperation Treaty)

(PCT Rule 90.5)

The undersigned person(s):
(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)

CICHOSZ, Vincent A.
Delphi Technologies, Inc.
Legal Staff MC 480-414-420
1450 W. Long Lake Road
Troy, Michigan 48007-5052
United States of America

hereby appoint(s) the following person as: [X] agent [ ] common representative

Name and address
(Family name followed by given name: for a legal entity, full official designation. The address must include postal code and name of country.)

CANTOR, Michael A., Reg. No. 31,152;
MURPHY, Keith J., Reg. No. 33,979;
FOX, David A., Reg. No. 38,807;
CURBELO, Pamela J., Reg. No. 34,676;
BEDINGFIELD, Herbert M., Reg.No.44,530;
LYMAN, George J., Reg. No. 44,884;
COLBURN II, Philmore H., Reg. No.35,101;
REIHER, Leah M., Reg. No. 39,341;
ELLIS, Edward J., Reg. No. 40,389;
VILLAR, Juan C., Reg. No. 34,271;
OLSON, Timothy H., Reg. No. 42,962;

Address: CANTOR COLBURN LLP
55 Griffin Road South
Bloomfield, CT 06002
DS

to represent the undersigned before

[X] all the competent International Authorities
[X] the International Searching Authority only
[X] the International Preliminary Examining Authority only

in connection with any and all international applications filed by the undersigned with the following Office

United States Patent & Trademark Office as receiving Office

and to make or receive payments on behalf of the undersigned.

Signature(s) *(where there are several persons, each of them must sign; next to each signature, indicate the name of the person signing and the capacity in which the person signs, if such capacity is not obvious from reading this power):*

Vincent A. Cichosz, Agent

Date: July 31, 2000

Form PCT/Model of general power of attorney (for several international applications) (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	FOR FURTHER ACTION	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
DP-301244 PCT		
International application No.	International filing date *(day/month/year)*	(Earliest) Priority Date *(day/month/year)*
PCT/US 00/41616	26/10/2000	27/10/1999
Applicant		
DELPHI TECHNOLOGIES, INC. et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 2 sheets.

[X] It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

   a. With regard to the **language,** the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

   [ ] the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

   [ ] contained in the international application in written form.

   [ ] filed together with the international application in computer readable form.

   [ ] furnished subsequently to this Authority in written form.

   [ ] furnished subsequently to this Authority in computer readble form.

   [ ] the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   [ ] the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. [ ] **Certain claims were found unsearchable** (See Box I).

3. [ ] **Unity of invention is lacking** (see Box II).

4. With regard to the **title,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established by this Authority to read as follows:

5. With regard to the **abstract,**

   [X] the text is approved as submitted by the applicant.

   [ ] the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. 2

   [X] as suggested by the applicant.

   [ ] because the applicant failed to suggest a figure.

   [ ] because this figure better characterizes the invention.

   [ ] None of the figures.

INTERNATIONAL SEARCH REPORT

Information on patent family membe

International Application No
PCT/US 00/41616

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5817920 A	06-10-1998	EP 0975957 A	02-02-2000
		WO 9841852 A	24-09-1998
US 5886248 A	23-03-1999	US 5739414 A	14-04-1998
		EP 0880691 A	02-12-1998
		JP 3055949 B	26-06-2000
		JP 11513113 T	09-11-1999
		WO 9729364 A	14-08-1997
EP 0811840 A	10-12-1997	JP 3027726 B	04-04-2000
		JP 10054822 A	24-02-1998
		US 5804050 A	08-09-1998

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 May 2001 (17.05.2001)

PCT

(10) International Publication Number
WO 01/34951 A2

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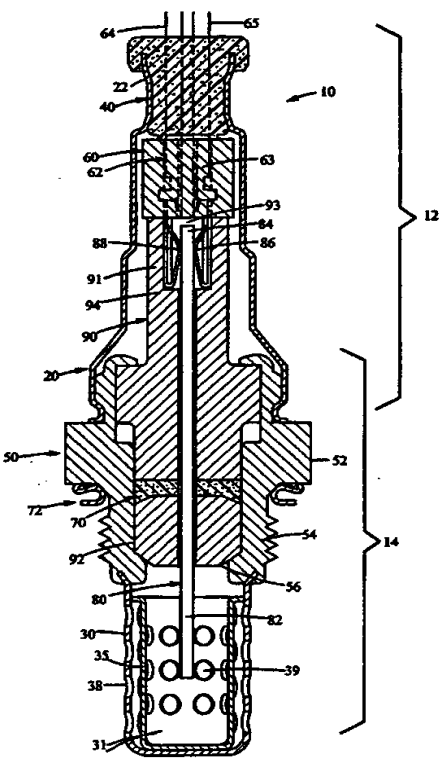
(54) Title: A GAS SENSOR TERMINAL ASSEMBLY AND METHOD OF PRODUCING SAME



(57) Abstract: A terminal connector assembly comprises: a terminal support (60), a terminal (62), (63) disposed at least partially within the terminal support (60), and a first insulator (90) having a passage (93) with an indentation (94) adjacent to the terminal (62), (63) and the terminal support (60). A gas sensor (10) and a method of producing a gas sensor (10) is also disclosed.

WO 01/34951 A2

A GAS SENSOR TERMINAL ASSEMBLY AND METHOD OF PRODUCING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

This case claims the benefit of the filing date of the provisional application, U.S. Provisional Application Serial No. 60/161,839, filed October 27, 1999 that is hereby incorporated by reference in its entirety.

TECHNICAL FIELD

This invention relates to gas sensors, and, more particularly, to gas sensor terminal assembly.

BACKGROUND OF THE INVENTION

Oxygen sensors are used in a variety of applications that require qualitative and quantitative analysis of gases. In automotive applications, the direct relationship between the oxygen concentration in the exhaust gas and the air-to-fuel ratio of the fuel mixture supplied to the engine allows the oxygen sensor to provide oxygen concentration measurements for determination of optimum combustion conditions, maximization of fuel economy, and the management of exhaust emissions.

A conventional stoichiometric oxygen sensor typically comprises an ionically conductive solid electrolyte material, a porous electrode on the exterior surface of the electrolyte exposed to the exhaust gases with a porous protective overcoat, and an electrode on the interior surface of the sensor exposed to a known oxygen partial pressure. Sensors typically used in automotive applications use a yttria stabilized zirconia based electrochemical galvanic cell with platinum electrodes, which operate in potentiometric mode to detect the relative amounts of oxygen present in the exhaust of an automobile engine. When opposite surfaces of this galvanic cell are exposed to different oxygen partial pressures, an

electromotive force is developed between the electrodes on the opposite surfaces of the zirconia wall, according to the Nernst equation:

$$E = \left(\frac{RT}{4F}\right) \ln\left(\frac{P_{O_2}^{ref}}{P_{O_2}}\right)$$

where:

E	=	electromotive force
R	=	universal gas constant
F	=	Faraday constant
T	=	absolute temperature of the gas
$P_{O_2}^{ref}$	=	oxygen partial pressure of the reference gas
P_{O_2}	=	oxygen partial pressure of the exhaust gas

Due to the large difference in oxygen partial pressure between fuel rich and fuel lean exhaust conditions, the electromotive force (emf) changes sharply at the stoichiometric point, giving rise to the characteristic switching behavior of these sensors. Consequently, these potentiometric oxygen sensors indicate qualitatively whether the engine is operating fuel-rich or fuel-lean, conditions without quantifying the actual air-to-fuel ratio of the exhaust mixture.

Sensors are electrically connected to the vehicle electrical system through the sensor body and wiring harness. Within the sensor is an element used for sensing exhaust gases. Contact pads are disposed on the exterior of the sensing element to provide for electrical communication between the sensing element and the vehicle electrical system. Edge card connectors or terminals are generally used to make contact with the sensing element via the contact pads. As illustrated in prior art Figure 1, a typical sensor 100 utilizes a spring clip 101 to hold an adaptor 104 comprising male 102 and female 103 terminals within the sensor 100. A glass support 105 and a wedge ring 106 is disposed between the upper insulator 107 and a glass seal 108. A protective shield 109 surrounds the lower portion of the wiring harness assembly. In conventional designs, the terminals also support the weight of the sensing element and position the sensing element within the sensor, as illustrated in prior art Figure 1. At the same time, the weight from the internal components of the wiring harness is also transferred to the terminals. Typically, the sensing element and terminals have problems with handling the weight of the wiring harness and the sensing element, as well as maintaining the position of the

sensing element within the sensor. The fragile elements have a tendency to break under the weight of the terminals and by movement within the sensor during the manufacture, testing, and operation of these conventional sensors.

What is needed in the art is a terminal connector that supports and aligns the sensing element within the sensor, while minimizing stress to the sensing element.

BRIEF SUMMARY OF THE INVENTION

The deficiencies of the above-discussed prior art are overcome or alleviated by a terminal connector assembly, gas sensor, and method of producing a gas sensor.

The terminal connector assembly comprises: a terminal support, a terminal disposed at least partially within the terminal support, and a first insulator having a passage with an indentation adjacent to the terminal and the terminal support.

The gas sensor comprises: a sensing element, having a lower portion disposed within a subassembly and an upper portion disposed within a wiring harness assembly comprising an upper shield disposed around a wiring harness. A terminal support is disposed within the wiring harness. A first portion of a terminal is disposed within the terminal support and in electrical communication with the sensing element. A first insulator is at least partially disposed within the upper shield and around the sensing element upper portion. The first insulator has a passage for receiving a second portion of the terminal, such that at least a portion of the first insulator is disposed between the terminal, the second portion and the upper shield.

A method of producing a gas sensor comprises disposing an upper portion of a sensing element within a wiring harness assembly comprising an upper shield disposed around a wiring harness. Disposing a lower portion of the sensing element within a subassembly and disposing a terminal support within the wiring harness. Also disposing a first portion of a terminal within the terminal support and in electrical communication with the sensing element. Disposing a first insulator at least partially within the upper shield and around the sensing element

upper portion. The first insulator has a passage for receiving a second portion of the terminal, such that at least a portion of the first insulator is disposed between the terminal, the second portion and the upper shield. Exposing the sensor to engine operating conditions.

The above-described and other features and advantages of the present invention will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

The apparatus and method will now be described by way of example, with reference to the accompanying drawing, which is meant to be exemplary, not limiting.

Figure 1 is a cross-sectional view of a prior art gas sensor design.

Figure 2 is a cross-sectional view of one embodiment of a gas sensor design.

Figure 3 is a side view of exemplary terminals, cables, and a sensing element.

Figure 4 is an isometric side view of an exemplary terminal support.

Figure 5 is an isometric bottom view of an exemplary terminal support.

Figure 6 is a cross-sectional view of an exemplary terminal support, taken along lines 6-6 of Figure 4.

DETAILED DESCRIPTION OF THE INVENTION

Sensors are used in automobile engines to monitor the exhaust for the presence of different gases. The sensor typically comprises: a wiring harness having an upper shield, a seal, electrical components, and the upper portion of a sensing element; and a subassembly having a shell, a lower shield, an internal shield, a high temperature material, and the lower portion of a sensing element. The sensing element within the sensor is a fragile device that should be maintained in position to prevent breakage. Conventional sensors are designed such that the weight of the wiring harness is distributed to the sensing element. In contrast to

conventional sensors, the terminals, terminal support and first insulator herein support and protect the sensing element from movement within the sensor, as well as helping to support the weight of the wiring harness.

Referring now to Figure 2, the exemplary oxygen sensor 10, having a wiring harness assembly 12 and a subassembly 14, is illustrated. The wiring harness assembly 12 generally includes the seal 40 and electrical components connected to the upper portion 84 of the sensing element 80 within the upper shield 20. The subassembly 14 generally includes the lower portion of the sensing element 80, an internal shield 35 in a lower shield 30, and a shell 50. Exemplary materials for the shields 20, 30, and 35 and for the shell 50 are stainless steels such as high chrome and/or high nickel stainless steels, and mixtures and alloys comprising at least one of the foregoing stainless steels, and the like, with all materials chosen for high temperature endurance, high-strength and corrosion resistance.

The fastener or seal 40 disposed within a portion of the upper end 22 of the upper shield 20, can comprise material capable of withstanding temperatures commensurate with the operation of an engine (e.g., temperatures up to about 1,000°C, with the sensor experiencing temperatures up to about 300°C). Typical materials include fluoroelastomer, silicone, rubber, perfluoroelastomer, as well as other conventional seal materials, and combinations comprising at least one of the foregoing materials. The seal can be made by conventional molding techniques known in the art.

One possible seal is disclosed in Patent Application _____, Attorney Docket No. DP-301500/DP-301244B (DEP-0133F) that is incorporated herein by reference in its entirety. This one-piece, multi-functional seal 40 provides dampening, structural integrity, and protects the sensing element 80 by preventing the intrusion of water or other contaminants from entering the sensor 10. The seal 40 can be designed to fit into the upper portion 22 of the upper shield 20 for a secure fit. The seal's optional flange provides additional sealing between the seal 40 and the upper shield 20. Once the upper shield 20 is under the flange, the seal 40 can be crimped in place by crimping operations known in the art, which distort or form the seal 40 to the shape of the upper shield 20, creating a seal 40

that closes off contaminants from entering the sensor. Additionally, during use, namely exposure to high temperatures, the flange of the seal 40 shrinks into the upper shield 20, thus providing added protection for the sensor 10 against exposure to contaminants.

As stated above, the seal 40 can act as a dampening device against any vibration or shock loads. The optional projections on the bottom of the lower portion of the seal 40 are designed to contact with the terminal support 60 and to dampen vibrations or shock loads that impact the sensor 10. The projections act similar to a spring, absorbing the vibrations while minimizing contact to the terminal support 60. Since, the seal 40 only physically contacts the terminal support 60 at the projections, an air gap is formed therebetween. This air gap insulates the seal 40, minimizing the convective transfer of heat from the lower sensor components to the seal 40.

To provide for electrical connection of the sensor 10, a terminal support 60 is disposed adjacent to the seal 40. The terminal support 60 may be formed of a material that is durable under sensor operation conditions. These materials, which should be chosen to provide for electrical insulation, thermal resistance, and mechanical support, can include thermoplastic; thermoset; ceramic, such as steatite, alumina, and the like; among others, and combinations comprising at least one of the foregoing terminal support materials, with ceramics and plastics often employed.

The terminal support 60 holds into place an edge card connector, terminal connector, or terminal(s) 62, 63 that are connected to cable(s) or wire(s) 64, 65. The cables 64, 65 connect the vehicle electrical system to the wiring harness 12. The cables 64, 65 can be comprised of materials that are generally those that are known in the art, including copper, brass, stainless steel, nickel, and the like, as well as combinations and alloys comprising at least one of the foregoing materials. The terminals 62, 63 are generally comprised of materials known in the art, which may include stainless steel, copper, brass, nickel, and the like, as well as combinations and alloys comprising at least one of the foregoing materials. Materials, and a terminal design, which provide a substantial spring force under sensor operating conditions is preferred.

The terminals 62, 63 are in electrical communication with the contact pads 86, 88 of the sensing element 80. Portions of the sensing element 80 are disposed within the upper shield 20, the shell 50 and the lower shield 30. The sensing element 80 can be a planar or flat plate sensing element of a known type. At a first end 82 thereof, disposed in lower shield 30, the sensing element 80 includes an exhaust constituent-responsive structure fabricated into the sensing element in a known manner, preferably along with a heater of a known type. Disposed at or near the second end of the sensing element 80 are contact pads 86, 88, that are comprised of conventional materials known in the art.

In addition to electrically connecting to contact pads 86, 88, terminals 62, 63 preferably physically contact the first insulator 90. This first insulator 90 is disposed within at least a portion of both the upper shield 20 and the shell 50. The first insulator 90 comprises a high temperature material (i.e., a material capable of withstanding the sensor operation conditions), to provide insulation for the sensor 10. Some possible high temperature materials which are chosen for electrical insulation, thermal resistance, and mechanical support, include ceramics and metals, among others, and combinations, alloys, and composites comprising at least one of the foregoing materials in the form of fibers (random, chopped, continuous, woven, and the like), woven and non-woven mesh, among others. The ceramic can include steatite, alumina, or the like, or combinations comprising at least one of the foregoing ceramics. Optionally, the first insulator 90 can comprise a ceramic upper portion comprising the shelf 94 and a metal mesh lower portion disposed through at least a portion of the shell 50. The first insulator 90 can be a cylindrical device with a passage 93 of various widths for the insertion of the terminals 62, 63 and the sensing element 80. The terminals 62, 63 are positioned such that the weight of the terminals 62, 63 is supported by the first insulator 90.

The first insulator 90 optionally comprises an indentation or shelf 94 that extends outward from the passage 93 within the interior of the upper portion 91 of the first insulator 90. The shelf 94 preferably extends into the first insulator 90 at a distance sufficient to receive terminals 62, 63, such that the terminals 62, 63 fit into, rest on, or are supported by an indentation or support shelf

94 near the top of the first insulator 90. Preferably, the shelf 94 preferably has a width substantially similar distance from an outside of one terminal to the outside of an opposite terminal. The first insulator 90 surrounds the sensing element 80 while providing support to and positioning the sensing element 80 within the sensor 10. By supporting the weight of the terminals 62, 63 and the terminal support 60, the first insulator 90 removes the weight and force from damaging the sensing element 80. The first insulator 90 can be connected to the sensor 10 through a crimping method, or other method known in the art.

The lower portion of the first insulator 90 is disposed within the shell 50. The shell 50 has a body portion 52 and a threaded portion 54. The body portion 52 is preferably shaped to accommodate a wrench or other tool for tightening the threaded portion 54 into a mount for an exhaust pipe or other component of an exhaust flow system, or wherever the gas sensor will be employed, thus, enabling a sensor chamber 31, to be located within a flow of gasses to be measured. The shell 50 can be coupled to the upper shield 20 by a crimping or other process known in the art.

Optionally disposed on a lower portion of the shell 50 is a gasket 72, which provides a source of tension to help retain sensor 10 in operational position and seal the sensor and manifold from gas leakage. Another optional item that can be disposed within the shell 50 adjacent to the sensing element 80 and between the first insulator 90 and the second insulator 92 is a talc pack 70 or other structural or sealing component. The talc pack 70 can be disposed between the first insulator 90 and the second insulator 92, or between the shell shoulder 56 and the insulator 90, 92 or mesh. The talc pack 70 holds the sensing element in place by compacting talc powder around it. Alternatively, the talc pack 70 serves as a leak resistant seal that can be obtained by employing an inorganic material such as talc, mica, kaolin, and the like, as well as combinations comprising at least one of the foregoing inorganic materials, between the sensing element 80 and lower shield 30.

Disposed within the shell 50 and adjacent to the talc pack 70 can be the second insulator 92. The second insulator 92 is comprised of the same or

similar high temperature material as the first insulator 90 and insulates and protects the sensor 10.

Adjacent to the second insulator 92 can be the sensing chamber 31. The lower shield 30 is securely coupled to the shell 50 such that a first end 82 of the sensing element 80 is disposed within the sensing chamber 31 to permit contact with and sensing of gas. The lower shield 30 defines the sensing chamber 31 and, disposed within the lower shield 30, is an internal shield 35 for receiving the sensing element 80. The lower shield 30 and the internal shield 35 incorporate a plurality of apertures 38, 39 for allowing passage of exhaust gas in and out of the sensing chamber 31 so that the gasses may be sensed by the receptive first end 82 of the sensing element 80.

To operate the sensor 10, an electrical connection needs to be secured between the sensing element 80 and the wiring harness 12 that connects to the vehicle electrical system. As shown in Figure 3, the terminals 62, 63 connect with the contact pads 68, 69 located on the sensing element 80 placing the terminals 62, 63 and sensing element 80 in electrical communication. The terminals 62, 63 can hold or retain the sensing element 80 in place by utilizing a spring design, as is known in the art. The extended piece 66, 67 of each terminal is depressed against the contacts 68, 69 of the element creating a spring-like effect. This keeps the element 80 under tension between the terminals 62, 63 and retains the electrical connection, as well as the position of the element 80 in the sensor 10. As illustrated in Figure 2, the terminals 62, 63 are held in place within the wiring harness 12 by two separate elements: a terminal support 60 and an first insulator 90. The terminals 62, 63 are allowed to flex and distribute vibration and shock loads to the terminal support 60 and the first insulator 90, thus protecting the sensing element 80.

Referring now to Figure 4, the terminal support or lock, shown generally at 60, is illustrated. The terminal support 60 is illustrated having a generally cylindrical shape with at least one flat side 120, however, other designs are possible such as multi-sided, and the like. Located within the top 122 of the terminal support 60 are channels or holes 130 for receiving terminals (not shown) and electrical cables (not shown). Referring now to Figure 5, the bottom 124 of

the terminal support 60 with at least one flat side 120 is illustrated. The figure illustrates the reverse side (the bottom 124) of the channels 130 that extend through the terminal support 60. Within the channels 130, an indentation or pocket 132 is created within each channel 130 for receiving and supporting the terminals (not shown).

Referring now to Figure 6, a cross-section of the terminal support 60 is illustrated. The channels 130 open through the top 120 and extend out through the bottom 124 of the terminal support 60. The indentations 132 located within the channels 130 create a larger space for receiving the terminals (not shown). The terminal support 60 isolates the terminals 62, 63 from each other and holds the terminals 62, 63 in position at the top of the sensing element 80. Consequently, the terminal support should be dielectric material having a sufficient number of channels 130 to receive the desired number of wires (not shown) and terminals. The particular spacing and orientation of the channels 130 is chosen based upon the desired number of cables and terminals, and manufacturing capabilities.

Because of the combination of the terminal support, first insulator and terminals, the sensing element will be protected from exposure to the weight of the terminals, movement within the sensor, as well as the effects of vibrations. As a result, the sensor life is extended. For example, while conventional sensors typically degrade, the present sensor can withstand vibration testing (e.g., 90 hours at about 950°C and 200 - 400 hertz, with an acceleration of 22G). In another test where many conventional sensors failed in about 100 hours (e.g., the sensor element breaks and/or the terminal connectors move creating unacceptable resistance), the present sensor withstood 2,000 hours of durability testing on an engine dynamometer (equivalent to about 150,000 miles on a car). Other tests which were successfully passed include a weight drop test (1 kilogram (kg) weight was dropped on the shell (commonly known as the "hex") at varying heights) and a ball drop test (100 gram ball was dropped from 1 meter onto the sensor at 4 different points). With the weight drop test the present sensor withstood drops from about 3 times as high as a conventional sensor (e.g., about 45 cm versus 15 cm for a conventional sensor). Additionally, with the ball drop test, the sensor

passed the test while conventional sensors failed. An additional benefit of this sensor design is that the terminal support system is easy to install and cost effective.

While preferred embodiments have been shown and described, various modifications and substitutions may be made thereto without departing from the spirit and scope of the invention, including the use of the geometries taught herein in other conventional sensors. Accordingly, it is to be understood that the apparatus and method have been described by way of illustration only, and such illustrations and embodiments as have been disclosed herein are not to be construed as limiting to the claims.

We claim:

CLAIMS

1. A gas sensor (10), comprising:

a sensing element (80), having a lower portion (82) disposed within a subassembly (14) and an upper portion (84) disposed within a wiring harness assembly (12) comprising an upper shield (20) disposed around a wiring harness;

a terminal support (60) disposed within said wiring harness;

a first portion of a terminal (62), (63) disposed within said terminal support (60) and in electrical communication with said sensing element (80); and

a first insulator (90) at least partially disposed within said upper shield (20) and around said sensing element upper portion (84), said first insulator (90) having a passage (93) for receiving a second portion of said terminal (62), (63), wherein at least a portion of said first insulator (90) is disposed between said terminal (62), (63), said second portion and said upper shield (20).

2. The gas sensor (10)of Claim 1, wherein said first insulator (90) is a material selected from the group consisting of a ceramic, metal, and combinations, alloys, and composites comprising at least one of the foregoing materials.

3. The gas sensor (10) of Claim 2, wherein said ceramic selected from the group consisting of including steatite, alumina, and combinations comprising at least one of the foregoing ceramics.

4. The gas sensor (10) of Claim 2, wherein said first insulator (90) is in a form selected from the group consisting of random fibers, chopped fibers, continuous fibers, woven fibers, woven mesh, non-woven mesh, and combinations comprising at least one of the foregoing forms.

5. The gas sensor (10) of Claim 1, wherein said terminal support (60) is a material selected from the group consisting of thermoplastic, thermoset, ceramic, and combinations comprising at least one of the foregoing materials.

6. The gas sensor (10) of Claim 5, wherein said ceramic is selected from the group consisting of steatite, alumina, among others and combinations comprising at least one of the foregoing ceramic materials.

7. A method of producing a gas sensor (10), comprising:

disposing an upper portion (84) of a sensing element (80) within a wiring harness assembly (12) comprising an upper shield (20) disposed around a wiring harness; disposing a lower portion (82) of said sensing element within a subassembly (14);

disposing a terminal support (60) within said wiring harness;

disposing a first portion of a terminal (62), (63) within said terminal support (60) and disposing in electrical communication with said sensing element (80); and

disposing a first insulator (90) at least partially within said upper shield (20) and around said sensing element upper portion (84), said first insulator (90) having a passage for receiving a second portion of said terminal (62), (63), wherein at least a portion of said first insulator (90) is disposed between said terminal (62), (63), said second portion and said upper shield (20); and

exposing said sensor (10) to engine operating conditions.

8. The method of Claim 7, wherein said first insulator (90) is a material selected from the group consisting of a ceramic, metal, and combinations, alloys, and composites comprising at least one of the foregoing materials.

9. The method of Claim 8, wherein said ceramic selected from the group consisting of including steatite, alumina, and combinations comprising at least one of the foregoing ceramics.

10. The method of Claim 8, wherein said first insulator (90) is in a form selected from the group consisting of random fibers, chopped fibers, continuous fibers, woven fibers, woven mesh, non-woven mesh, and combinations comprising at least one of the foregoing forms.

11. The method of Claim 7, wherein said terminal support (60) is a material selected from the group consisting of thermoplastic, thermoset, ceramic, and combinations comprising at least one of the foregoing materials.

12. The method of Claim 11, wherein said ceramic is selected from the group consisting of steatite, alumina, among others and combinations comprising at least one of the foregoing ceramic materials.

13. A gas sensor (10), comprising:

a sensing element (80), having a lower portion disposed within a subassembly (14) and an upper portion disposed within a wiring harness assembly (12) comprising an upper shield (22) disposed around a wiring harness;

a one-piece seal (40), said seal (40) having a body disposed in a first portion of said upper shield (20), and a flange wherein an edge of said upper shield is disposed between at least a portion of said flange and said body;

a shell (50) disposed around said lower portion of said sensing element (80);

a first insulator (90), wherein at least a portion of said first insulator (90) is disposed between said sensing element (80) and said shell (50);

a lower shield (30) disposed around an end of said sensing element (80), said lower shield (30) in physical contact with said shell (50), and having a plurality of apertures (38);

at least one terminal (62), (63) in electrical communication with said sensing element (80); and

a terminal support (60) in physical contact with said terminal (62), (63).

14. The gas sensor (10) of Claim 13, wherein said subassembly (14) further comprises a talc pack (70) disposed within said shell (50) between said first insulator (90) and said lower shield (30).

15. The gas sensor (10) of Claim 14, wherein said subassembly (14) further comprises a second insulator (92) disposed within said shell (50) between said talc pack (70) and said lower shield (30).

16. The gas sensor (10) of Claim 13, wherein said first insulator (90) is a material selected from the group consisting of a ceramic, metal, and combinations, alloys, and composites comprising at least one of the foregoing materials.

17. The gas sensor (10) of Claim 16, wherein said ceramic selected from the group consisting of including steatite, alumina, and combinations comprising at least one of the foregoing ceramics.

18. The gas sensor (10) of Claim 16, wherein said first insulator (90) is in a form selected from the group consisting of random fibers, chopped fibers, continuous fibers, woven fibers, woven mesh, non-woven mesh, and combinations comprising at least one of the foregoing forms.

19. The gas sensor (10) of Claim 13, wherein said terminal support (60) is a material selected from the group consisting of thermoplastic, thermoset, ceramic, and combinations comprising at least one of the foregoing materials.

20. The gas sensor (10) of Claim 19, wherein said ceramic is selected from the group consisting of steatite, alumina, among others and combinations comprising at least one of the foregoing ceramic materials.

FIG. 1
PRIOR ART

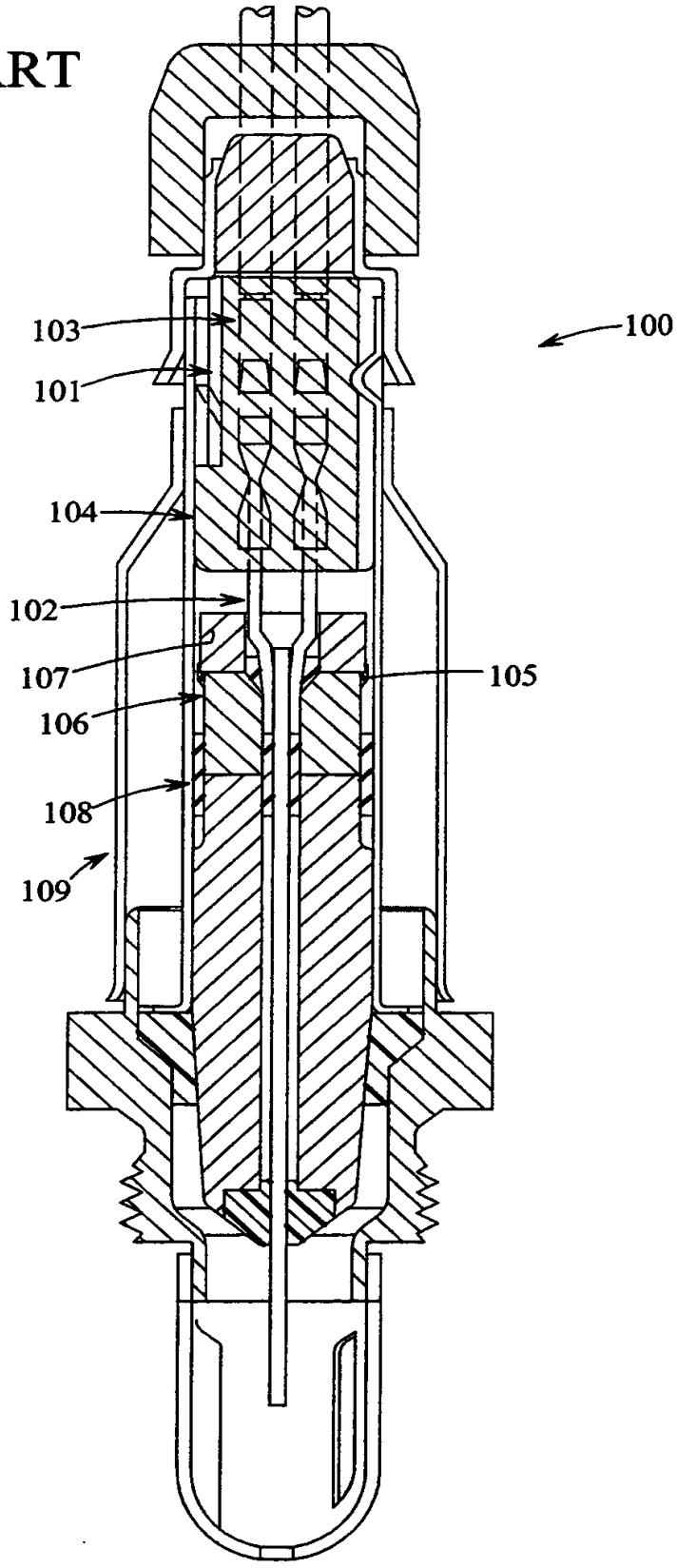


FIG. 2

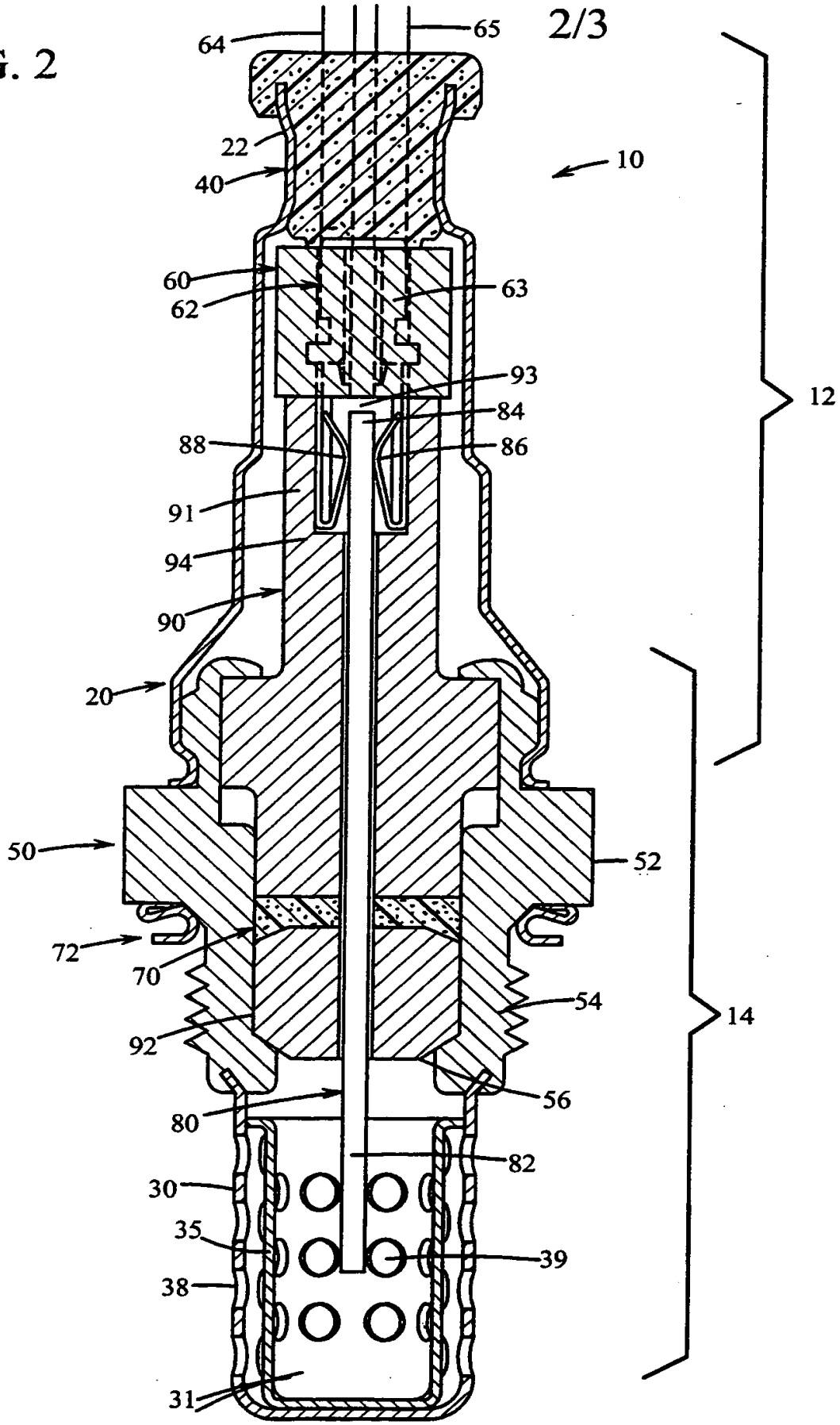

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FIG. 4

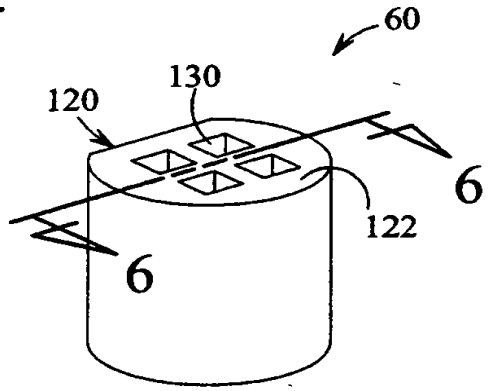


FIG. 5

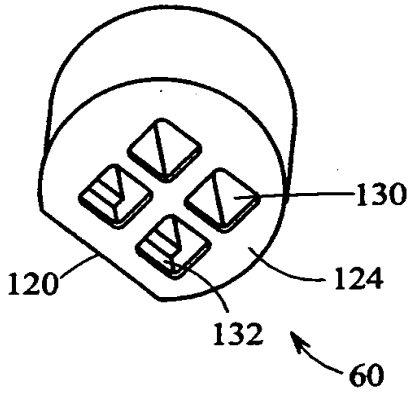


FIG. 6

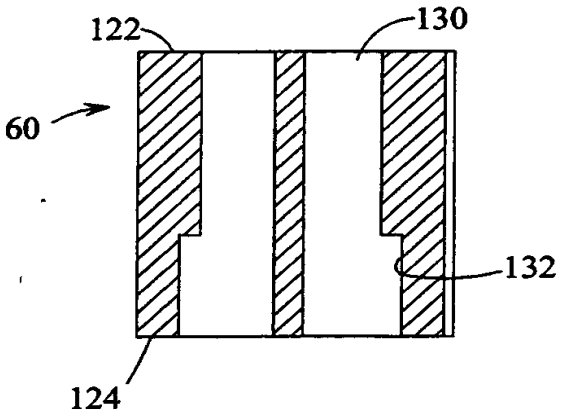
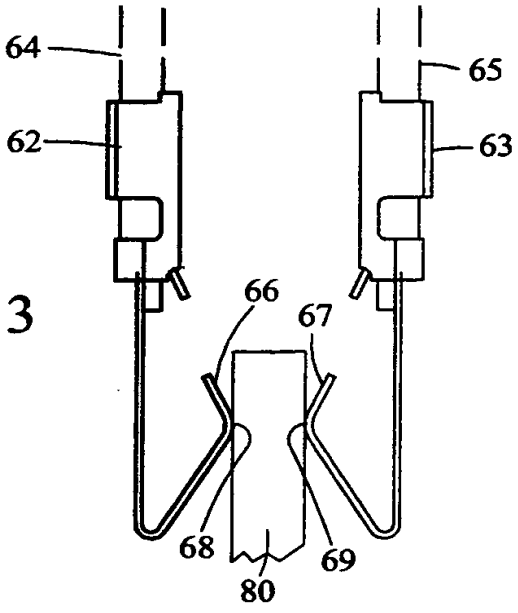


FIG. 3



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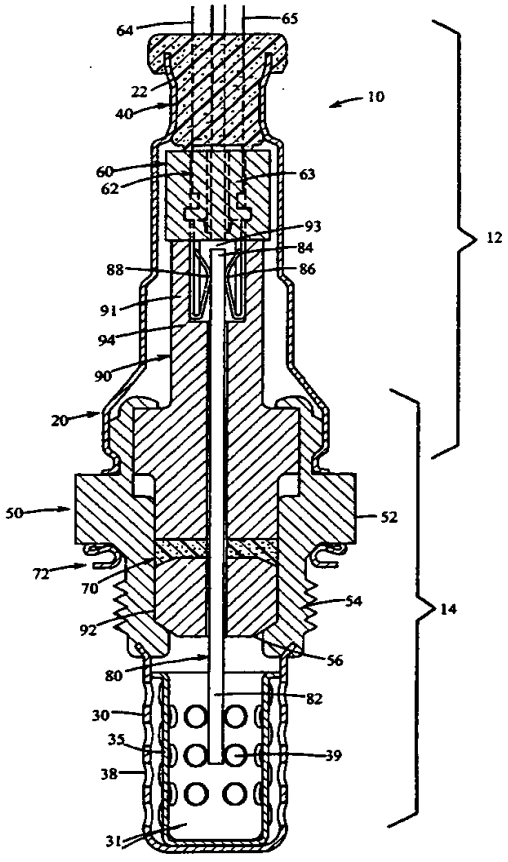
(54) Title: A GAS SENSOR TERMINAL ASSEMBLY AND METHOD OF PRODUCING SAME



(57) Abstract: A terminal connector assembly comprises: a terminal support (60), a terminal (62), (63) disposed at least partially within the terminal support (60), and a first insulator (90) having a passage (93) with an indentation (94) adjacent to the terminal (62), (63) and the terminal support (60). A gas sensor (10) and a method of producing a gas sensor (10) is also disclosed.

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INTERNATIONAL SEARCH R RT

Inte tional Application No
PCI/US 00/41616

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01N27/407

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A X	US 5 817 920 A (ACHEY DAVID EARL ET AL) 6 October 1998 (1998-10-06) abstract column 2, line 10 - line 80 column 3, line 42 - line 65; figure 1	1-12, 14-20 13
A	US 5 886 248 A (FOURNIER ROBERT GREGORY ET AL) 23 March 1999 (1999-03-23) abstract column 5, line 27 - line 46; figure 4	1-20
A	EP 0 811 840 A (NGK SPARK PLUG CO) 10 December 1997 (1997-12-10) abstract page 6, line 36 -page 7, line 18; figure 1	1-20

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
22 June 2001	03/07/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Kempf, G

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INTERNATIONAL SEARCH R RT

nformation on patent family members

Intr tional Application No
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